



The Democratic Republic OF The Sudan
Ministry OF Culture And Information



RAHAD IRRIGATION PROJECT

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1977

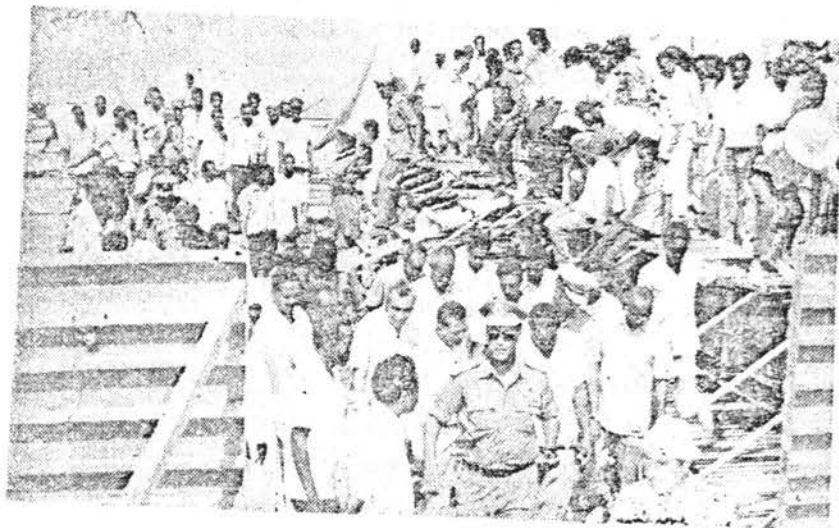
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FOREWORD

The inauguration of the Rahad Irrigation Project by President Gaafar Mohamed Nimeiri in December 1977, marks a very important stage in the agricultural development of the Sudan. The project brings 300,000 feddans of fertile land under irrigation, planned for a high degree of agricultural mechanisation, which sets new standards for projects of this kind.

The main crops to be grown are medium staple cotton and groundnuts, and the area contains almost 17,000 tenancies. Apart from giving a boost to the national economy, the project will bring a measure of prosperity to close on 100,000 people to be settled within the area.

President Nimeiri's visit to the Project, 1976

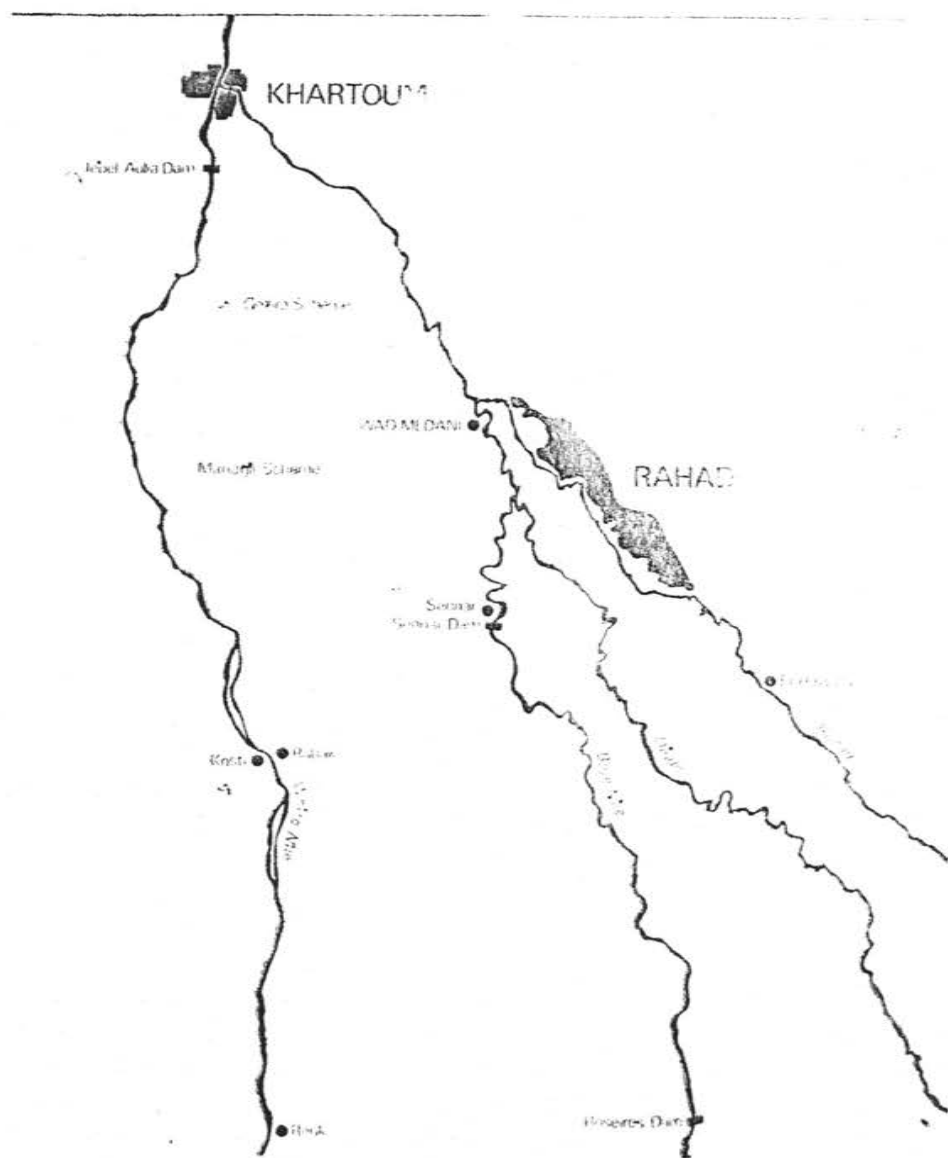


Sudan, the largest country in Africa, with a land area of about one million square miles, is dependent very much on its agriculture. The arable and livestock agriculture accounted for about 40% of the gross domestic product in 1970 employing nearly 90% of the working population. About 80 million feddans (a feddan is about 1.04 acres or 0.42 hectares) are taken up by rangelands and about 16 million feddans are under crops, of which approximately one quarter are irrigated. The Gezira-Managil system accounts for about half of the 4 million feddans under irrigation and the Khashm El Girba scheme a further 400,000 feddans.

With the construction of the Roseires Dam on the Blue Nile, which was completed in 1966, more stored water became available for irrigation. A series of soil surveys in the early and mid-sixties in the Blue Nile, White Nile and Main Nile basins identified areas which would be suitable for irrigation development. By far the most promising was that on the east bank of the River Rahad. The area is a flat alluvial plain with vegetation varying from almost bare with isolated scrub in the north to savannah and more dense bush in the south. In the past, agricultural usage has been restricted to rain-grown sorghum because of the lack of irrigation water.

The Rahad is a seasonal river flowing from July to November. At first, it was considered that part of the area could be irrigated using Rahad flood water and a study of this possibility was commenced in late 1963. During the study it became evident that it would be possible to have a perennial irrigation to the area constructing a canal from the Blue Nile. A pre-investment study in 1964-65 on the Blue Nile east bank, including an extended area on the Rahad, increased the potential development area to about one million feddans. The Rahad stage I area amounted to 410,000 feddans and it was proposed to irrigate it by means of a long gravity canal linking to the Roseires reservoir. After further consideration a modified scheme was put forward, with a reduced area of 300,000 feddans and a shorter supply canal, which involved pumping from the Blue Nile.

THE PROJECT AREA



The Project Area is located on the east bank of the River Rahad and extends from near Mafaza in the south to the confluence of the Rahad and Blue Nile in the north. The area is a flat alluvial plain with a gentle slope from south-east to north-west of about 0.5 metre per kilometre. The supply canal from the Blue Nile originates from Meina, near Singa, crosses under the River Dinder at a point just south of El Gueisi and joins the River Rahad just north of Mafaza. The project main canal stems from the River Rahad and skirts the eastern edge of the area passing to the west of the Qalat Arang range of hills of which Jebel Fau is the highest.



The cost of the project, as estimated in July 1977, is LS. 145 million, of which LS. 68 million is in foreign currency.

Finance for the foreign currency element is being provided by the following organisations :

	SM (approx-
International Development Association (IDA)	68
Kuwait Fund for Arab Economic Development (KF)	48
Saudi Development Fund (SF)	28
Arab Fund for Economic and Social Development (AF)	14 ½
United States Agency for International Development (USAID)	11

The local currency costs, including taxes and duties, are being financed by the Sudan Government.

THE COMPONENTS OF THE PROJECT, THEIR COSTS AND FINANCING ARRANGEMENTS FOR THE FOREIGN ELEMENT

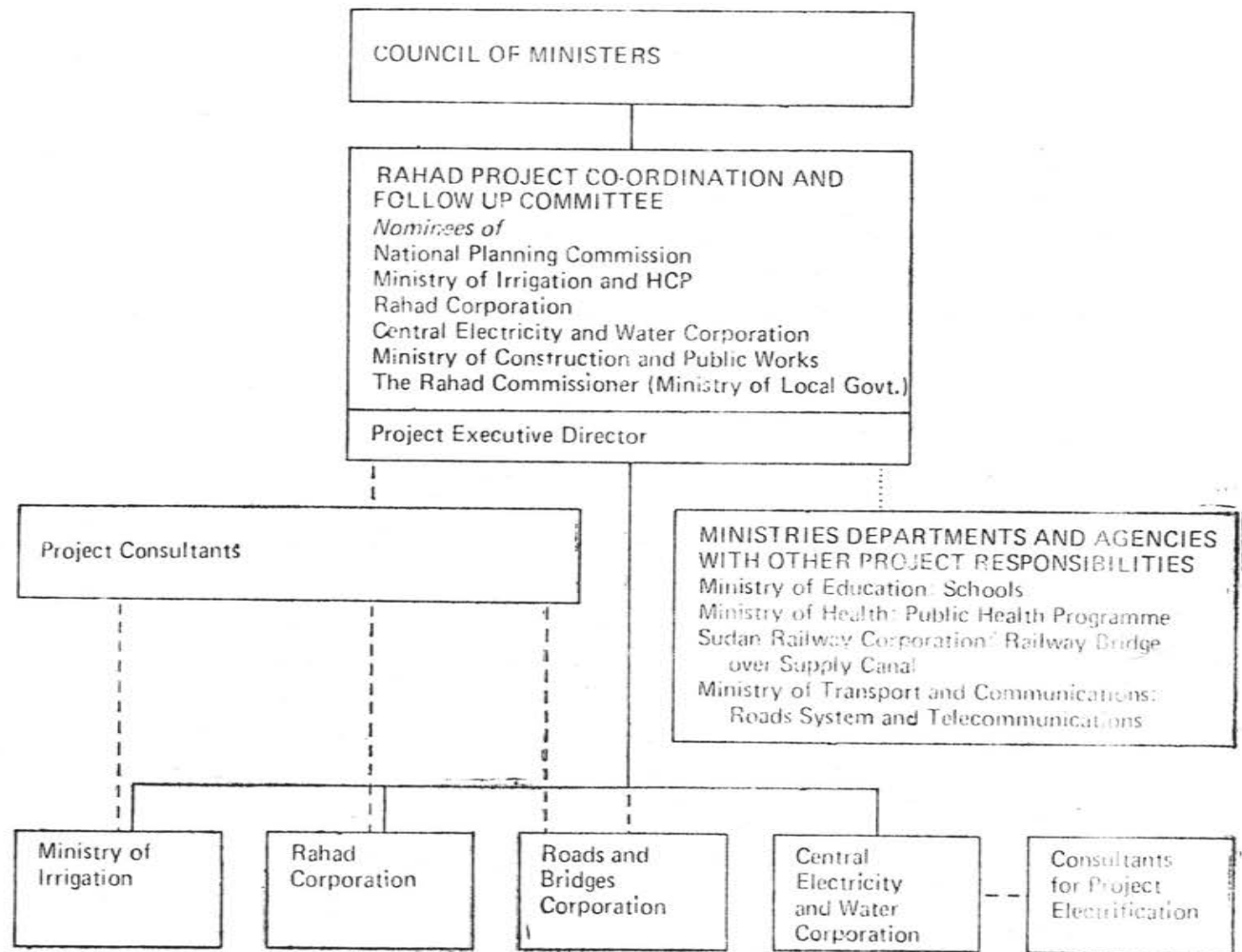
Project Component	Approximate Cost LS.	Foreign Currency Finance
Water control equipment, pumping plant, building materials and consultants	8,468,000	Joint : IDA and KF
Construction contracts, including power transmission	64,904,000	
Force account work and miscellaneous including local costs of supply contracts, overheads etc.	42,773,000	Joint : IDA, KF and SF
Materials supply contracts	2,729,000	Parallel : KF
Equipment supply contracts	2,631,000	
Vehicles and equipment	4,810,000	Parallel : USAID
Vehicles and equipment	4,400,000	
Roads system	14,176,000	Parallel : AF
Total Project	144,891,000	

Implementation

The agreements for international finance with IDA, Kuwait Fund and USAID were concluded in early 1973 and the procedures for implementation then commenced. Further financing was arranged in early 1975, when the Saudi Fund and the Arab Fund joined the financiers.

Contracts were placed for major irrigation structures, ginneries, buildings, telecommunications system, roads system and power lines, agricultural and construction equipment and vehicles and many other materials and equipment. The construction of the irrigation distribution system was carried out directly by the Sudan Government. Miscellaneous buildings and small construction contracts have generally been done by local or negotiated contract.

Responsibility for the execution of the work was devolved by the Government of Sudan among a number of agencies under the direction of and co-ordinated by a Project Executive Director having the rank of Deputy Minister. The main two agencies involved were the Ministry of Irrigation and Hydro-Electric Energy, responsible for the irrigation and drainage system, and the Rahad Corporation (a Public Corporation responsible to the Minister of Agriculture) set up to administer the completed project, who were responsible for the agricultural works and most of the infrastructural works. Electrical power transmission and distribution were allocated to the Public Electricity and Water Corporation and the Roads System to the Roads and Bridges Public Corporation. Other Government Departments, consultants and specialist advisers assisted these four authorities in various aspects of their work. The organisation is shown schematically on the following page



IRRIGATION AND DRAINAGE SYSTEM

Main Works

The main works included in the system comprise:

An electrically powered pumping station at Meina on the Blue Nile, some 200 kilometres downstream of Roseires Dam, having a capacity of 105 cubic metres per second (cumeecs).

A supply canal, 80 kilometres long with a capacity of 105 cumeecs, carrying water by gravity from Meina, crossing under the River Dinder in a siphon and discharging into the River Rahad at a point 7 kilometres downstream of Mafaza.

A barrage and head regulator on the Rahad, 1 kilometre downstream of the supply canal cutfall.

An irrigation and drainage system covering 300 000 feddans net cultivable area.

Meina pump station

The Meina Pump Station, the largest pump station of its kind in Africa, houses eleven pumps, each with a capacity of 9.55 cumeecs.

The pumps are of the vertical spindle hydrodynamic type, arranged for priming from the intake and driven by electric motors. Electric power is supplied by means of a 33 kV transmission line from Sennar with a sub-station sited adjacent to the pump station to step down the voltage to 11 kV. The pumping head varies, according to the water levels in the Blue Nile and the Supply Canal, from about 6.7 metres to about 14.7 metres.

Excavation for the foundations, which are 20 metres below ground level, totalled 260 000 cubic metres (m^3). Because of the proximity of the station to the river and the fact that the upper stratum is underlain by sand, a well-point dewatering system was used to control the sub-surface water level during construction.

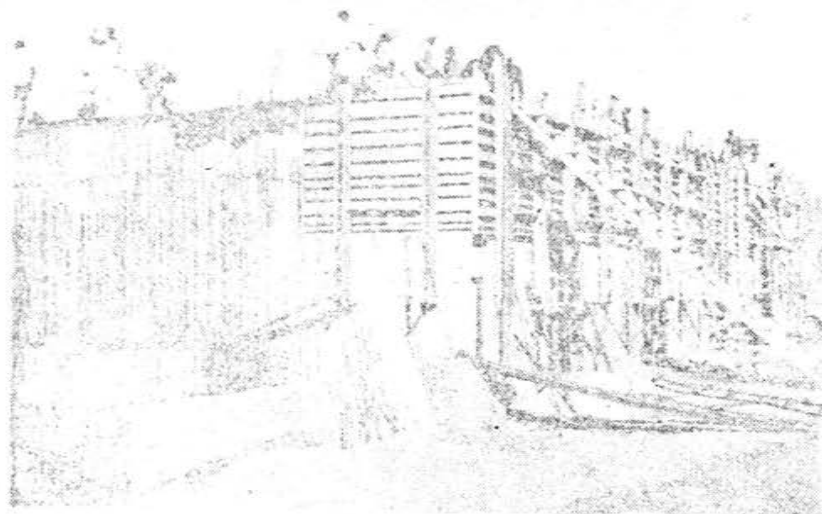
The superstructure of the station measures 79 metres long, 13 metres wide and 12 metres high, and is a reinforced concrete portal frame with brick infill and facing. 10 000 m^3 of concrete and 4 500 m^3 of masonry for pitching were used in the structure.

Supply Canal

The supply canal has a bed width of 35 metres and a water depth of 3.5 metres. Earthworks totalled 11 million cubic metres and

excavation was carried out by either scrapers or a combination of draglines and scrapers.

The terrain traversed is generally flat and featureless with light bush and a gentle slope from south to north. In addition to the three main structures, there are eight road bridges, two cross drainage structures and one railway bridge along the length of the canal. The canal discharges into the Rahad by means of an ungated fall structure. A particularly difficult section of the canal was that on either side of the River Dinder, where the water level is as much as 8 metres above ground level and high embankments were required.



Meina Pump Station discharge structure

Dinder Siphon

The supply canal intersects the River Dinder after 24 kilometres and passes under the river in an inverted siphon. The siphon consists of 3.4 metre square reinforced concrete barrels and is 250 metres long. There are metal gates at the upstream end to control the flow. Excavation for the structure totalled 129 000 m³ and 12 000 m³ of concrete and 3 500 m³ of masonry were placed.

The Dinder, like the Rahad, is a seasonal river and is dry from January until July. Construction work in the river bed took place

during the dry season and a well-point dewatering system was used to control the sub-surface flow.

Rahad Barrage

The Rahad Barrage is sited about 1 kilometre downstream of the supply canal outfall and has nine lifting gates of 4 metres span. The head regulator for the project main canal is an integral part of the structure, with six gates of 4 metres span. The barrage maintains the water level about 2 metres above normal river flood level, and a small reservoir is created upstream. The structure is of reinforced concrete construction with masonry facings to piers and abutments. Construction of the barrage and head regulator involved some 47 000 m³ of excavation, 7 000 m³ of concrete and 10 000 m³ of masonry.



Rahad Barrage, view from downstream, 1977

Project Area Canalisation and Drainage

The main canal has a design capacity at its head of 100 cumecs and a length of 90 kilometres. It feeds the area by means of a system of canals of descending order of magnitude, viz. Major, Minor, Double Abu (three) (double watercourse), and Abu (three) (watercourse) down to Abu Sitta (farm channel in the Angaya or Isma

ing for a system. Where furrow irrigation is practised, the furrows are supplied direct from Abu Ishreen.

The drainage system takes surface runoff via the field and minor drains into the main collector drains. Drains are also provided running parallel and adjacent to the Main Canal to protect it from runoff from the higher land to the east.

Earthworks for the main and major canals total 26 million cubic metres, there are approximately 800 kilometres of minor canals, 400 kilometres of double abu ishreens and 4 500 kilometres of abu ishreens; excavation for main drains amounts to about 6.5 million cubic metres and there are 1 200 kilometres of other drains.

The canal system is designed to operate on a night storage system.

INFRASTRUCTURE

The project area is divided into three Groups of approximately 100,000 feddans, which are each sub-divided into three Blocks. The main centres are the Project Headquarters, three Group Headquarters and nine Block Headquarters, three of which are located within the Group Headquarters. In addition, there are 35 farmers settlements.

The infrastructural works include such things as buildings, electricity supplies, processing facilities, research farm, roads, tele-communications system, public health facilities, education, police and postal services, etc., all necessary for the proper functioning of the project.

Buildings

These include headquarters, offices and staff houses, with all the necessary utilities and roads. There are 820 houses, 10 bachelors quarters, 2 resthouses, 27 office blocks, 18 workshops, 11 stores and 9 car sheds.

Electricity Supplies

These include :

- (i) A transmission line from Sennar to Meina.
- (ii) A transmission line from Wad Medani to the Project Headquarters.
- (iii) Electrical distribution to main centres within the project area.

Processing Facilities

These include :

- (i) A cotton ginning complex at Project Headquarters, comprising four saw ginning factories capable of processing 840,000 kantars (approximately 262,080,000 lb) of seed cotton per ginning season, four warehouses and ancillary buildings and services.
- (ii) Groundnut decortecating plants.
- (iii) Warehouses at Hawata and Port Sudan.

Research Farms

These include a seed multiplication farm to supply good quality seeds and a research farm to investigate agronomic problems.

Road System

The system comprises a network of all-weather roads within the project area, including some 80 kilometres of spine road, 80 kilometres of feeder road, a bridge on the River Rahad and several smaller bridges and culverts.

Telecommunications System

This comprises a complete telecommunications network, connecting the main project centres and linking to the national telecommunications network.

Public Health Facilities

These include the provision of village water supplies, a central hospital, clinics, health centres, etc., and also an initial supply of molluscicides and equipment for bilharzia and malaria control.

Public Services

These include the provision of education, police, postal service, etc.

AGRICULTURE AND SETTLEMENT

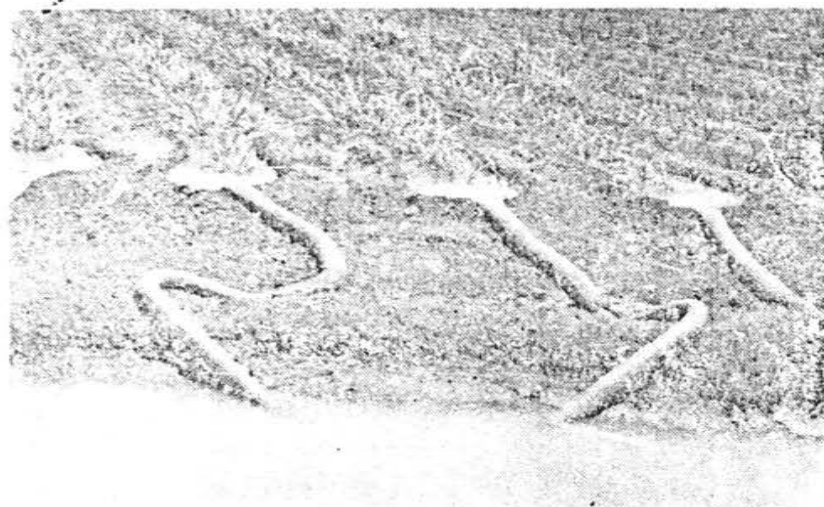
Like other irrigation schemes in the Sudan, the project area is sub-divided into farm tenancies. The Rahad Corporation provides agricultural, processing and marketing facilities to the tenant and maintains close overall control. The tenancies are of two kinds, either 22 feddans (9.24 hectares) on which the standard rotation is grown or 5 feddans (2.1 hectare) on which vegetables and fruit are grown.

There are approximately 12,800 of the former and 4,000 of the latter type. The standard rotation has two plots of 11 feddans each in adjacent numbers (area served by abu ishreen canal), one plot growing Acala cotton and the other 8 feddans Ashford groundnuts and 3 feddans fodder or groundnuts at the tenant's option. Cropping is therefore 100 per cent intensive. Fodder has been permitted in the rotation to enable tenants to integrate some of their present livestock holdings into the scheme.

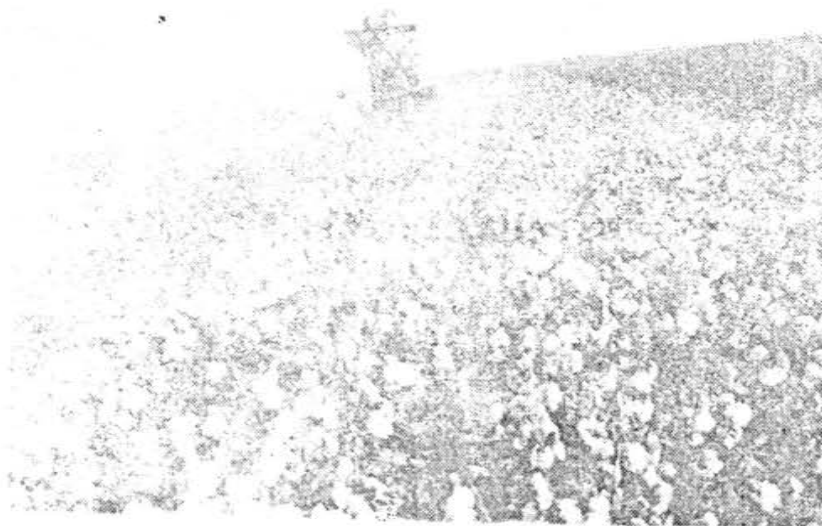
The 16,800 tenants have been drawn from either within the area itself or nearby. Previously only the northern part had any settled population since drinking water was available from wells. In the southern part, where no groundwater exists, the population was concentrated in villages along the Rahad River, depending on pools in the river bed for their drinking water during the dry season.

The leading tribes are the Shukria, Gaalien, Massalamia, Kawahla, Halaween, Rufa and Ashraf. One of the main planning objectives has been to create settlements which, although formed from diverse cultures, will eventually work as integrated units. With this in mind both village and agricultural plots have been carefully allocated.

Financial assistance has been given to tenants to establish themselves within the project.



Tambul Pilot Farm, long furrow irrigation.



Tambul Pilot Farm, Cotton



Bush clearance .

THE FUTURE

By any standards, the Rahad Irrigation Project which transforms some 300,000 feddans of semi-desert into a fertile farming area, with all the support infrastructure such as roads, regional centres, housing, offices, workshops, schools and medical centres, involving the resettlement of nearly 100,000 people, is a huge and imaginative undertaking. The development will bring prosperity to a whole new region which in the past has been somewhat neglected because of the lack of that vital commodity, so necessary for agricultural development in an arid area, water.

The omens for the future are good. With the yields which are confidently expected, an economic rate of return of nearly 20 per cent will be achieved.

The project will have a considerable impact on the national economy, especially the earnings of foreign exchange, and will bring good rewards to the tenants.

With the success of the scheme will go rural development in the form of many different kinds of facilities, both social and industrial.

which will enable the area to be a well integrated and substantially self-sufficient region.

This is only the beginning. Much hard work and dedication is required, but, with this in mind, the project has a great opportunity of setting an example for other similar developments, both in the Sudan and elsewhere.

PROJECT DATA

Area	300,000 feddans (net cultivable).																
Crop areas	<table border="0"> <tr> <td></td> <td style="text-align: right;">feddans</td> </tr> <tr> <td>Cotton, Acala</td> <td style="text-align: right;">140,000</td> </tr> <tr> <td>Groundnuts, Ashford</td> <td style="text-align: right;">102,000</td> </tr> <tr> <td>Fodder</td> <td style="text-align: right;">38,000</td> </tr> <tr> <td>Fruit and vegetable gardens</td> <td style="text-align: right;">7,500</td> </tr> <tr> <td>Forestry and pastures</td> <td style="text-align: right;">12,500</td> </tr> <tr> <td>Fallow</td> <td style="text-align: right;">-----</td> </tr> <tr> <td>TOTAL</td> <td style="text-align: right;">300,000</td> </tr> </table>		feddans	Cotton, Acala	140,000	Groundnuts, Ashford	102,000	Fodder	38,000	Fruit and vegetable gardens	7,500	Forestry and pastures	12,500	Fallow	-----	TOTAL	300,000
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Forestry and pastures	12,500																
Fallow	-----																
TOTAL	300,000																
Tenant holdings, number and size	Standard rotation : 12,727 of 22 feddans Vegetable/fruit : 4,000 of 5 feddans																
Irrigation system	<p>Meina Pump Station : Design capacity 105 cumecs at 10m pumping head 11 No. 1.1 megawatt pumping units.</p> <p>Supply Canal : Design capacity 105 cumecs Rahad Barrage : Design flood capacity 250 cumecs</p> <p>Main Canal Head Regulator : Design capacity 100 cumecs</p> <p>Main Canal : Design capacity 100 cumecs at head, length 90 Km.</p>																
Consultants	<p>To USAID : Louis Berger Inc., USA To Public Electricity and Water Corporation : Societe General pour l'Industries, Switzerland. To Ministry of Irrigation, Rahad Corporation and Roads and Bridges Public Corporation : Sir M. MacDonald & Partners, UK, in association with the following specialist sub-consultants : British Cotton Growing Association Ltd, UK (Cotton Ginning), Hunting Technical Services Limited, UK (Agricultural Services-), James Nisbet & Partners, UK (Quantity Surveying for Buildings), Rendel Palmer and Tritton, UK (Roads) and Shankland Cox Partnership, U.K. (Planning and Building)</p>																

CONSTRUCTION CONTRACT DATA

Contract Number	TITLE	CONTRACTOR	Contract Value LSx			
R 2/A	Rahad Barrage and Canal Head (Civil Works)	Sayed Abdu aSayed and Partners, Sudan	1.95	R 5	Ginning Complex	Main Contractor : Sarkis Izmirlian Corporation, Sudan Principal Sub-contractors : (Civil Works) Middle East Construction Co Ltd, Sudan (Ginning Plant) Murrery Piratinga Machinery Corporation, USA (Steelwork) H Young & Co Overseas Ltd, UK
R 2/B	Dinder Siphon (Civil Works)	Public Corporation for Irrigation and Earthmoving, Sudan Advisers : Torno SpA Italy Sub-contractor (dewatering equipment) : Millars Wellpoint International, UK	3.66	R 8	Warehouses at Port Sudan	Contract not yet awarded
R 2/C	Meina Pump Station (Civil Works)	Public Corporation for Irrigation and Earthmoving, Sudan Advisers : Torno SpA, Italy Sub-contractor (dewatering equipment) : Millars Wellpoint International, UK	0.23	R 9	Central Workshop Complex	Contract not yet awarded
R 3	Meina Pump Station Pumping Plant	Maschinenfabrik Andritz, Austria	3.96	R 9/5	Telecommunications System	Contract not yet awarded
R 4/A	Project Headquarters Phase I	Six Construct International SA and Saudi Sudanese Engineering and Contracting Co Ltd (Joint Venture), Sudan	1.34	Project Highway System	Contract not yet awarded	
R 4/B	Group Headquarters	Public Corporation for Building and Construction, Sudan	2.50	R 10/1	110 KV Transmission Lines	Energoinvest, Yugoslavia
R 4/C	Project Headquarters Phase III Group Headquarters I and II Infrastructure Groups I, II and III and Project Headquarters	Six Construct International SA and Saudi Sudanese Engineering and Contracting Co Ltd (Joint Venture) Sudan	1.63	R 10/2	110/33/11 KV Substations	Gruppo Industrie Meccaniche per Impianti All'Estero SpA, Italy
			12.22	R 10/3	Power Line Carrier Equipment	Tel:etra SpA, Italy
				R 11	Block Headquarters	Public Corporation for Buildings and Construction, Sudan
				Note :	The works undertaken directly by the Ministry of Irrigation (Force Account) include the following : excavation for Supply Canal, Main Canal and minor canalisation and drainage; project canalisation and drainage structures; closing embankments at Rahad Barrage; bush clearance.	

SUPPLY CONTRACT DATA

The following materials and equipment contracts have been awarded for use in the Project

CONTRACT NUMBER	DESCRIPTION AND SUPPLIERS
R 8.1	Water Control Equipment, Rausomes and Rapier Ltd., UK.
R 8.2A	Constructional Plant and Equipment, including: truck tractors with trailer, Oshkosh International, USA; 4 generating sets, 2 mobile workshops and 10 vibratory pokers, Gatherhope Ltd., UK; 6 tractors, British Leyland, UK.
R 8.2B	Workshop Equipment, including: 2 turret lathes and 2 cylinder honing machines, Nissho-Iwai, Japan; power hacksaw, Tedo Hugo Thomas, Germany; crankshaft grinder, Schov & Co., Denmark.
R 8.5	Cement (20 000 tonnes), Saducom S.A.
R 9.1	Building Materials, comprising: reinforcement and structural steel, Antwerp Steel Export, Belgium; timber, Holger Lundin AB, Sweden; ironmongery, Adrian Stokes (Overseas) Limited, UK; plumbing materials, Delta Water Fittings, UK; builders sundries, British Screw Co Ltd; roofing materials, Societe Industriale Libanaise, Lebanon.
R 9.4	Agricultural Plant and Equipment, comprising: 30 tractors, Ford; 10 harrows, Oppenheimer International Corporation, USA; 60 land planes and 15 ditchers, Eversman Incorporated, USA; 12 tankers and 6 trailers, Burnett & Co., UK; 6 mounted sprayers, Gebruder Holder, Germany; 4 ditchers, Werklust, Netherlands.
R 9.4A	Agricultural Plant and Vehicle, comprising: 200 tractors, Massey Ferguson, UK; 130 harrows, 200 planters and 18 ploughs, Oppenheimer, USA; 237, ridgers and 168 fertilizers, Francesco Nardi and Figli, Italy; 3 motor graders, Wabco, USA; 20 ploughs, Gheradi, Italy; 62 motor cycles, Toyota Tsusho Kaisha Ltd., Japan.

R 9/4B	Agricultural Plant, Workshop Equipment, comprising: machine tools, welding equipment and specialised tools, Jos Hansen and Soehne, Germany; garage equipment and hand tools, Nissho Iwai, Japan; woodwork equipment, Tedo Hugo Thomas, Germany; crane equipment, RCF Tools, UK; generators, Grahame Puttick, UK; lathes, Colchester Lathe Co., UK.
R 9/4C	Agricultural Plant, including: 200 Massey Ferguson tractors, Agricultural Bank, Sudan.
R 9/4D	Groundnut Harvesters, comprising: 120 harvesters and 165 windrowers, Harrington Manufacturing Co., USA.
R 9/6	Chemicals for Control of Waterborne Diseases, comprising: 91 tonnes DDT, Philagro, France; 12 300 litres Temephos, Cyanamid, Greece; 68 200 litres Triflormorph, Shell, Netherlands; 30 000 litres Niclosamide, Bayer, Germany.
R 9/7	Materials for Village Water Supplies, comprising: 40 pumpsets, Kirloskar Oil Engines Ltd., India; 28 pumpsets, Grundfos A/S, Denmark; well casings and screens, Bristol Composite Materials, UK; steel pipes and fittings, Kalinga Tubes, India; 60 water tanks and towers, Braithwaite & Co., UK; 40 chlorinators, Paterson Candy UK.
R 9/8	Flexible Siphon Tube, 90 000 metres, Intergroup... Greece.
R 9/9	Electrical Transmission Equipment, including: 46 transformers, 1 200 cutouts, 19 600 insulators, conductors and wires, structural steel and reinforcement, Project and Equipment Corporation of India Ltd; cable boxes, Delta Enfield Cables Ltd, UK.
R 9/11A	Survey Equipment and Vehicles, including: 22 levels, Wild Heerbrugg, Switzerland; 31 pick-ups and 1 station wagon, Sercobe, Spain; 5 tankers and 19 six tonnes chassis, International Harvester, USA.
R 10/1	Railway Bridge Steel-Work, Voest Alpine, Austria. The following items have still to be awarded
R 8/3	Timber, Reinforcement and Structural Steel.
R 8/4	Materials for Ministry of Irrigation Houses.

- R 9/4C Agricultural Plant: 50 balers, 50 cultivators, 1 000, sprayers, 20 pumps, 20 mounted sprayers and 6 000 spare tyres.
- R 9/8A Flexible Siphon Tube: 800 km.
- R 9/9 Electrical Transmission Equipment: isolators, expulsion fuses, electric meters and street lamps.
- R 9/10 Survey and Office Equipment.

The following equipment was supplied under USAID for use in the Project

32 tractors, Fiat Allis; 22 tractor scrapers and motor graders, Wabco, 2 truck tractors, GAR Internacional; 2 low bed trailers, Hobb International; 10 dump trucks, White Truck Group Internatinal; 4 steel cutting saws, New World Research Corporation; 2 telescopic cranes, Grove International; 30-9 m concrete mixers, Brown & Sites; front end loader, Caterpillar Tractor Co. 96 pick-ups, Ford; 20 concrete vibrators and spares, Combined Agencies Corporation; 8 land planes and 10 tilting trailers, Oppenheimer; 6 harrows, Rcme Industries; 20 offset harrows, Allis Chalmers; 4 tankers and 4 mobile workshops Phoenix Manufacturing Co; equipment and tools for central repair shop, Harold Dessau International; mechanical hand tools for agricultural and irrigation department, George Warner & Co.

In addition, the Ministry of Irrigation has purchased Construction Equipment, including: 5 D-9 tractors and 4 641 B motorised scrapers, Caterpillar Tractor Co.

